Space Weather Technical Forecast

Issued on Monday, 06 March 2023 at 00:32 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: M-class flares (R1-R2/Minor-Moderate radio blackouts) likely. Chance of Minor Geomagnetic Storm G1 intervals. Electron fluence is Active.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with an M5 flare peaking at 05/2136UTC from AR3243 in the northwest. There are currently ten sunspot regions on the visible disc. AR3242 in the northeast is the largest and most magnetically complex region on the disc, with a delta spot within its intermediate portion. AR3243 has continued to develop with increasing area and some complexity. AR3246 has rotated onto the northeast limb, with a further new region arriving on the southeast limb, both of which are currently difficult to analyse due to foreshortening. Other regions are either stable or showing some minor development. There are currently no significant Earth-directed CMEs in the forecast, although the potential for a couple of glancing blows is discussed below.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 by DSCOVR, has been connected to a high speed stream (HSS) associated with CH81/-. Wind speeds have been at strong to elevated levels, between 500-620km/s. The density was mostly average or below. The IMF, Bt, was mostly weak, with a couple of brief moderate peaks of 8nT. The north-south component, Bz, varied weakly between +/-6nT, but was mostly southward directed. The phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet to Active (Kp2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at Background levels. Electron flux at GOES16 has been mostly high with a peak of 6750pfu at 05/1620 UTC. Electron fluence rose above the Active threshold (1e8 integrated flux) during the period, with a value of 2.13e8 integrated pfu recorded at 06/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain moderate with further M-class flares, with a slight chance of rising to high with any isolated X-class flares. The main flare risk is AR3242 and AR3243, with a declining risk from AR3234 over the west limb.

Solar Wind / Geomagnetic Activity: No significant Earth-directed CMEs feature in the current forecast. However there is a low risk of glancing blows which could possibly arrive during Day 1, then during Days 2 or 3 (06 to 08 March). Otherwise, the main feature of interest is the current HSS related to CH81- which is likely to only slowly wane from later on Day 1 or more likely through Day 2 (07 Mar). A much smaller non-persistent equatorial coronal hole, CH82/-, may prolong elevated or slightly elevated wind speeds through much of this period. Earth is currently very close to the March equinox, and as such negative polarity features will give a stronger geomagnetic response at this time of year.
Geomagnetic activity is expected to be Quiet to Active (Kp 1-4), with an ongoing risk of G1/Minor

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

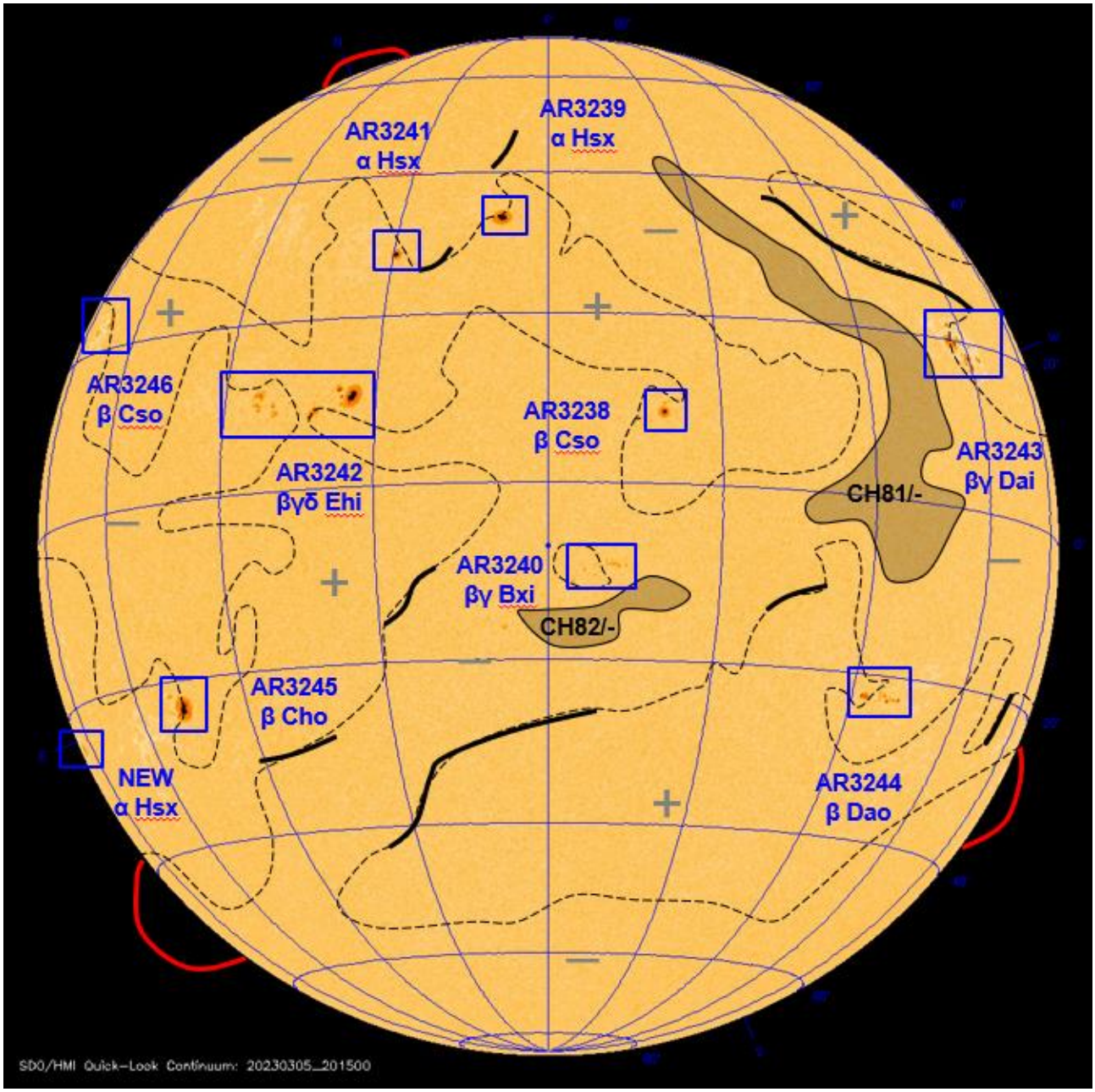
Storm (Kp5) intervals. There is a very low risk of stronger geomagnetic activity in association with any CME glancing blows.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels, but with a slight chance of reaching S1 or greater should any larger flares occur. Electron flux is likely to continue at high levels but with uncertainty due to the possibility of CME glancing blows suppressing levels. Electron fluence is above the Active (1e8 integrated pfu) threshold, and is likely to remain above Active levels through the guidance period albeit with some uncertainty.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 1. Solar Analysis Valid 05/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

No significant Earth-directed CMEs feature in the current forecast. However there is a low risk of glancing blows from the CMEs associated with the X2.1 flare on 03/1752 UTC, and the M5.2 flare on 04/1557UTC, which MOSWOC Enlil ensemble forecasts are signalling could possibly arrive during Day 1, then during Days 2 or 3 (06 to 08 March).

Otherwise, the main feature of interest is the HSS related to CH81- which is likely to only slowly wane from later on Day 1 or more likely through Day 2 (07 Mar). A much smaller non-persistent equatorial coronal hole, CH82/-, may prolong elevated or slightly elevated wind speeds through much of this period. Earth is currently very close to the March equinox, and as such negative polarity features will give a stronger geomagnetic response at this time of year.

Geomagnetic activity is expected to be Quiet to Active (Kp 1-4), with an ongoing risk of G1/Minor Storm (Kp5) intervals. There is a very low risk of stronger geomagnetic activity in association with any CME glancing blows.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	20	10
Strong	G3	No	5	5	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

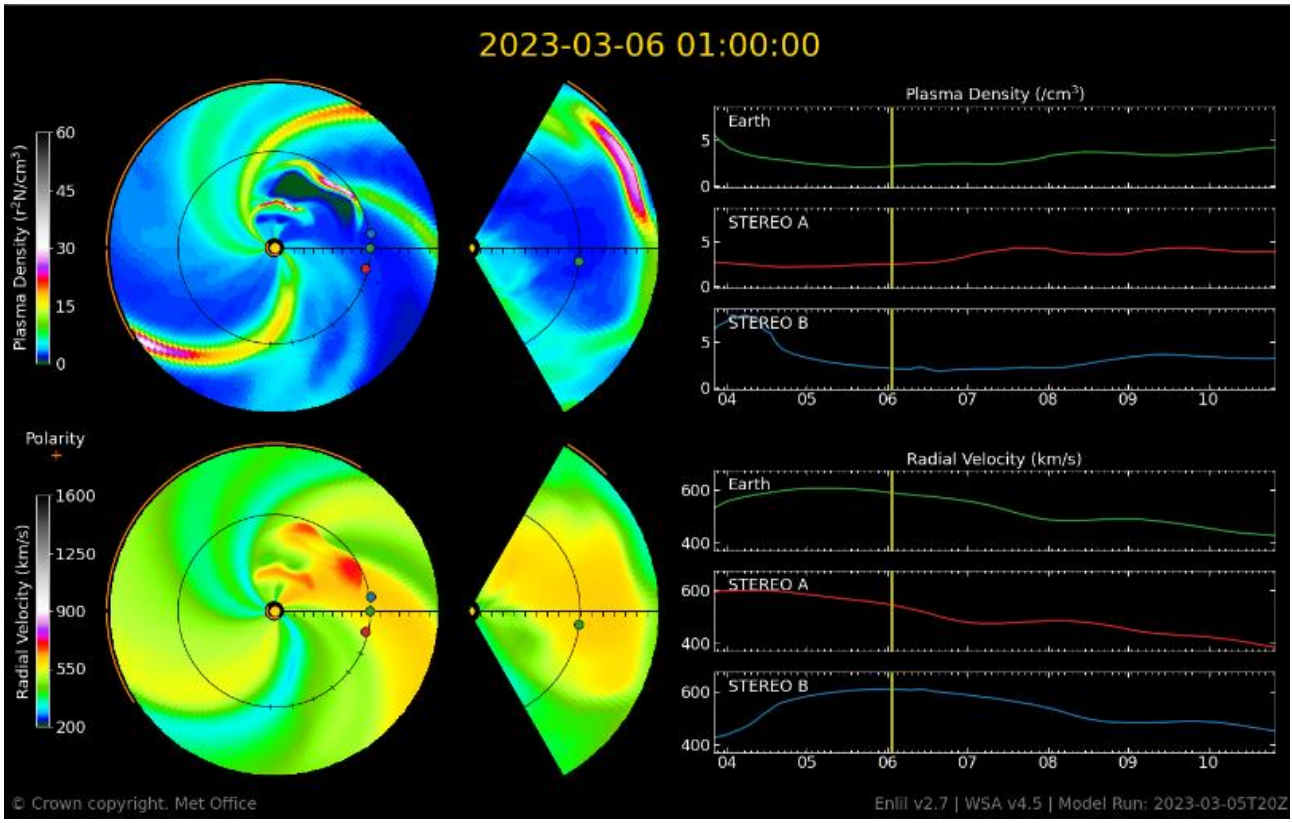
Geomagnetic Activity - Earthbound Coronal Mass Ejections

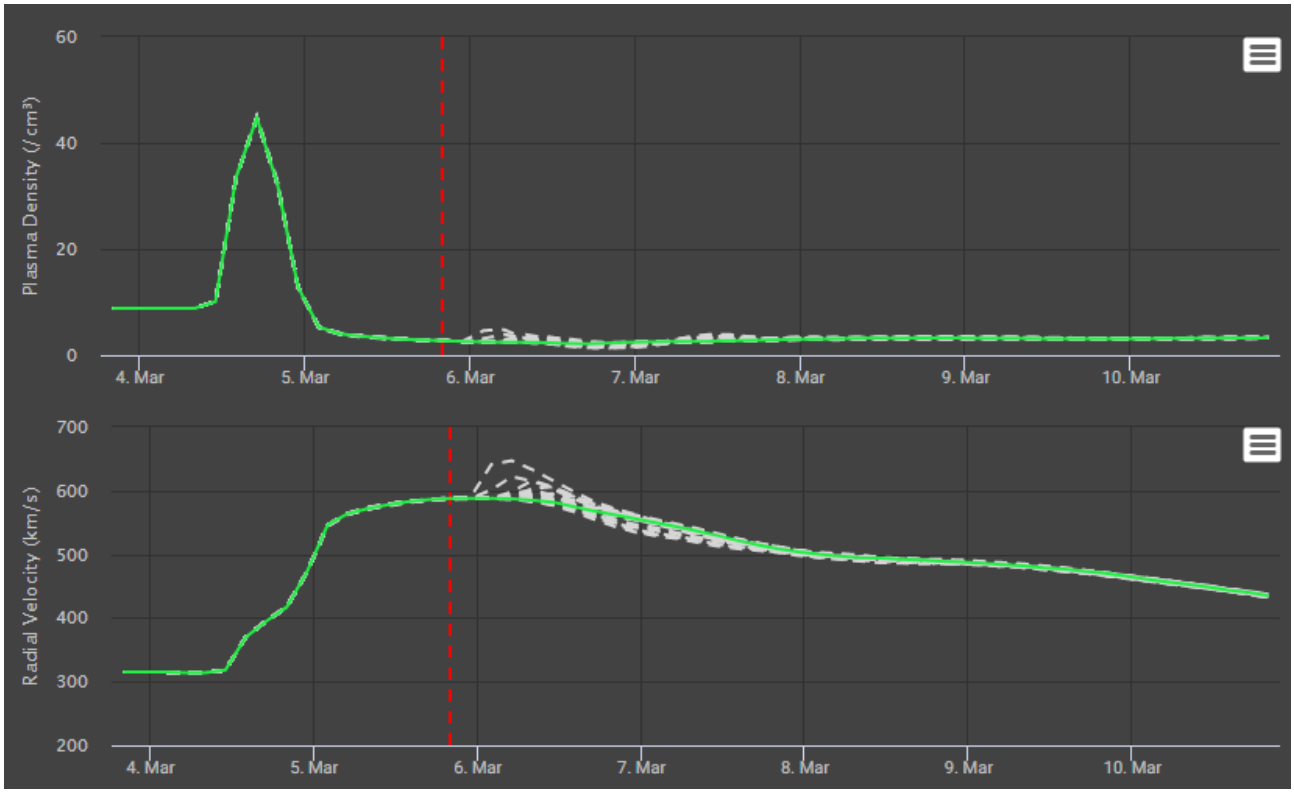
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: MOSWOC Enlil and ensemble, showing a very slight risk of glancing CME blows. Otherwise, a gradual decline in wind speeds but with a slight increase later in the period.





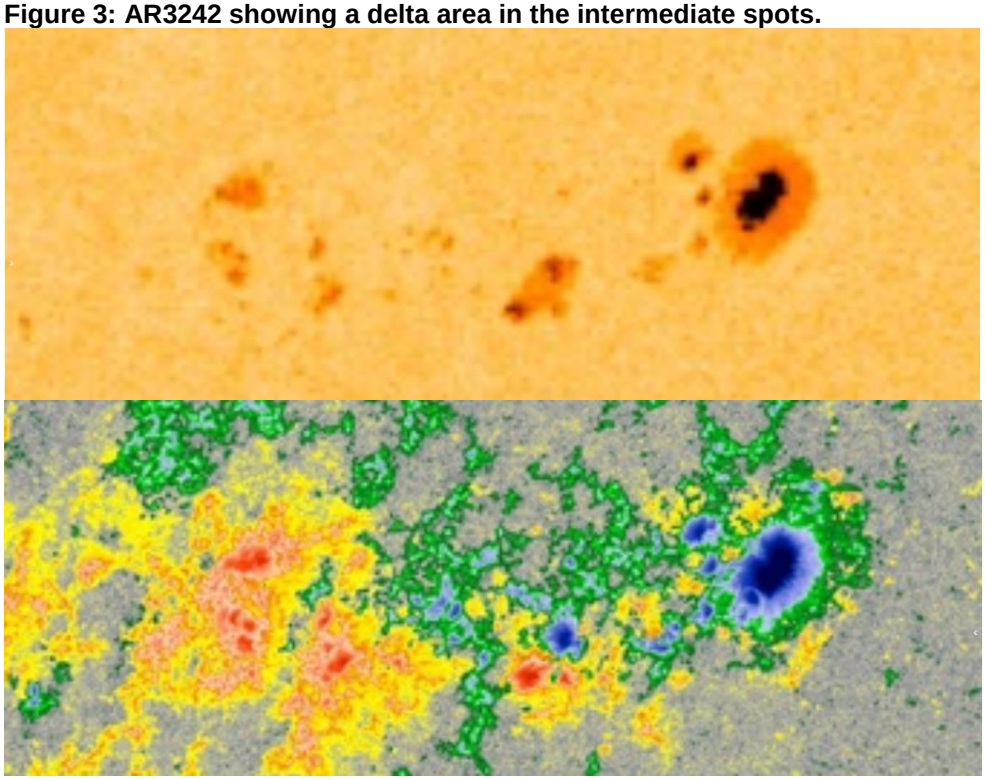
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
There are currently ten sunspot regions on the visible disc. AR3234 has rotated off the northwest limb, but will contribute a declining proportion to the flare risk through Day 1 (06 Mar). AR3242 (Ehi/Beta-Gamma-Delta) in the northeast is the largest region, which contains a delta spot within its middle portion. AR3243 (Dai/Beta-Gamma) in the northwest has continued to grow with some magnetic complexity, and is responsible for the largest flare of the last 24 hours. There are two regions near the east limb which are difficult to analyse at present due to foreshortening effect, although it is likely they are both more complex than they currently appear. Far side data does suggest several sunspot regions just over the eastern limb with further regions probably emerging onto the visible disc during this period. Their potential contribution to any increase in flare risk through this period is difficult to assess at present. Moderate solar activity is likely to continue with further M-class flares and a slight chance of isolated X-class flares giving High solar activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: AR3242 showing a delta area in the intermediate spots.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. AR3234 is now over the west limb, but will contribute a declining portion to the risk of S1 or greater events occurring through Day 1 (06 Mar) and perhaps into Day 2 (07 Mar). In the meantime, AR3242 will be rotating towards centre disc, posing an increased risk of proton flux increasing with any larger flares. AR3243 in the northwest has also developed recently and was responsible for an M5 flare, so this is now contributing a small amount to the risk of a proton event. Overall, the probabilities have been kept flat through the period with AR3242 taking over from AR3234 as the main risk area.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

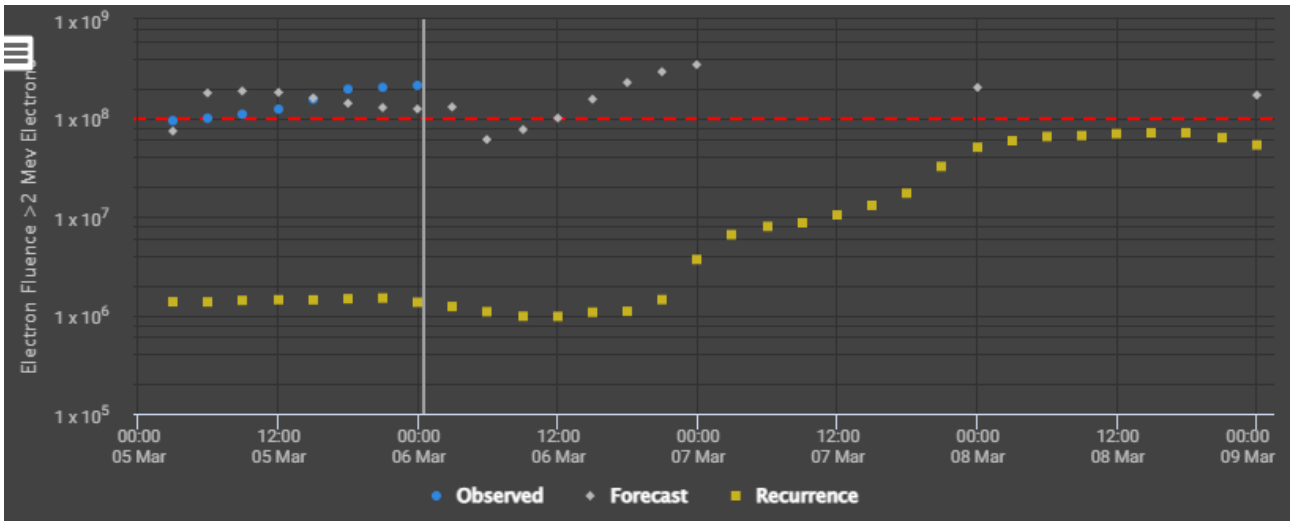
© Crown Copyright 2023. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
Electron flux is currently at high levels after recent HSS effects. It is likely to stay this way through much of the period, although perhaps becoming suppressed should we see any CME glancing blows at Earth in the coming days. Any CME arrival is low confidence, however, lending uncertainty to the electron forecast. The recent fairly prolonged period of fast winds is likely to have significantly charged the radiation belt, which is probably still compressed by the current HSS. As this wanes, electron flux levels have the potential to rise sharply as the radiation belt de-compresses and expands back to fully encompass GEO.

Electron fluence is currently above the Active threshold (1e8 integrated flux), which is in good agreement with the REFM forecast. Fluence is expected to remain above the Active threshold throughout much of the period, although the potential for CME glancing blows could drop it below, but this is lower confidence. As mentioned above, there is also the possibility of a rise in fluence levels in the coming days, should significant additional charging have occurred which may reach GEO as the radiation belt de-compresses.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	80	70
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	5	5	5

Figure 4: MOSWOC REFM showing an above Active forecast for the next three days, which seems reasonable.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.